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ENTOMOLOGICAL NEWS

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Ecological Notes on Three Species of Solitary Bees

By FRANK P. SIVIK, North Carolina State College, Raleigh

Studies on the ecology and life history of solitary bees have become important because of the vital role of these bees in the pollination of many plants (Linsley *et al.*, 1952). Such studies, furthermore, may contribute to our understanding of the phylogeny of the group (Michener, 1953). It is the purpose of this paper to record notes on three vernal species, all of which were originally described and named by Mitchell (1936, 1937 and 1951). Both *Andrena macra* and *Megachile rubi* visit flowers of *Rubus* sp., and the latter also visits *Cuscuta* and *Senecio*. *Megachile oenotherae* usually visits *Oenothera* sp. but has been found on *Ceanothus* sp. and *Pentstemon* sp.

No mating of any of these three was ever seen to occur at the nesting site during the writer's daily visits.

During rainy weather *A. macra* and *M. rubi* remained in their burrows.

Andrena macra. The adult males and females were described from specimens collected for a period of 19 years, the first being in 1935. As far as the writer knows this bee is found only in North Carolina about five miles outside of East Raleigh. The nesting site, exposed mostly to the west, is near a railroad bank and about two yards from a small pond. This bee appears to nest gregariously, and apparently the species requires a hard-packed soil in an area where water is available throughout the nesting season. *A. macra* makes its appearance almost simultaneously with the first flowers of *Rubus* sp.

The first day of flight for this bee was on April 14, 1954, with the males coming out first. They were prevalent for six days

and on the seventh and final day of their flight just a few were flying. The males preceded the females by only one day and their parasites, *Nomada* sp., by six. Six days after the males emerged, some of the females were noted entering the burrows, head first, laden with pollen. The parasites were in flight, hovering over the site, for 54 days. Neither the parasites nor the host remained outside of the burrow during the night.

The burrows were not spaced equally near each other; they appeared to be very close in some instances but not in others. They averaged 5 mm. in diameter and penetrated the clay soil as a smooth circular hole. There were many "push-ups" near the burrows but no attempt was made to measure them because of the existing terrain, which was sloping in some places.

Square yard counts of burrow entrance holes were made, using a measured square yard string. Fifty such counts were made with a total of 228 burrow holes. After digging 50 of these holes (a straw was used to indicate direction of the burrow and a post-hole digger and trowel were used for digging), the writer noted that some of the burrows were not finished and if finished (?) were not occupied. The depth of the burrows ranged from three inches to one which was three feet, the average being 18 inches. The burrows went straight down. No eggs or any of the immature stages were located.

The female cleans and excavates the tunnels. Two were observed bringing up soil particles; this process was checked for 1½ hours. It took an average of 2½ minutes for the bees to go down and come up with a load. They carried the soil particles under the abdomen with the hind pair of legs, while the front and mid pair furnished locomotion. As the bees backed out of the nest to the opening, the soil particles were pushed up out of the hole by means of the hind legs with the ventral surface of the abdomen serving as a guide. Usually they gave a good, final push with the tip of the abdomen, and the soil particles were out on the ground level. When this was accomplished the bee waited a second and then hurriedly continued down the cavity. Once a female bee was observed removing a pine needle, about two inches long, from its burrow and this was done in the same manner mentioned above.

Two females, in separate burrows, were noted with their heads just slightly out. With urging the bees flew off. These bees were in cell-like burrows which were about the same depth as the length of the entire body of the bee. The inside surface of the burrow was very smooth and no "push-ups" were nearby.

The type soil at the *A. macra* nesting site was worsham loam. The chemical analysis is as follows: a pH of 5.5, very low in calcium, phosphorous and potassium and contains 0.4 per cent of organic matter.

This nesting site was under observation for 19 years—how long it existed prior to this time is unknown. Unfortunately, the bee population is greatly decreasing which may be due to a weed-killer used by the railroad or by many other factors, such as predators; for example, dragon-fly adults or even birds which are very numerous in the area.

Megachile (*Xeromegachile*) *rubi.* A few individuals were found nesting in sandy loam, on and along an almost unused, unpaved road, about eight miles east of Raleigh, along the Neuse River. On April 29, 1954, both males and females were flying; how long they were out prior to this date is unknown. This species was first collected in 1922 and in North Carolina is found at Raleigh and at Harker's Island near Beaufort. Two females were observed excavating nests. They removed the soil particles with their hind legs, placing the soil outside of the nest with a fast, quick, hard push, aided by the tip of the abdomen, which then patted the soil into place. The eight nests investigated showed no particular exposure, i.e., facing either north, south, east or west. All of the nests, in about a 45° slope, averaged 1½ inches down from the ground level and were horizontal, 3½ inches. Two of the burrows had three cells, three had two and three had only one cell; all were arranged end to end. Both the cell caps and cell walls were made from leaves of the sweet birch, *Betula lenta* L., which was in a thick growth near the site. The cell walls were roughly rectangular and appeared to be cemented together. Each cell was about ⅝ inch long and ¼ inch in diameter, with about 8–10 pieces to the cell wall, and with about 4–5 to the cell caps. The insect egg was placed on its end, off center, on top of the pollen

mass. The larval stage was about 11 days. The full-grown larva did not completely fill the cell as in each there was about 1/8th of the pollen remaining in the bottom of the cell. It took one day for the pre-pupa to spin the cocoon. The type soil at this site was cecil sandy loam. The chemical analysis is as follows: a pH of 5.6, medium in calcium, very low in phosphorous and potassium and contains 0.4 per cent of organic matter. No parasites were noted at this nesting area.

Megachile (*Megachiloides*) *oenotherae*. The first *M. oenotherae* was collected in 1922. According to Mitchell (1936), its range is from New Jersey, along the coast to Texas and Oklahoma. Two males were observed to spend the night inside the blossoms of *Oenothera fructicosa* L. A female was observed making its nest in one of the *Andrena macra* burrows, using *Oenothera* petals for the cell caps and what seemed to be the *Oenothera* leaves for the walls. This was the only one observed.

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Notes and News in Entomology

Under this heading we present from time to time, notes, news, and comments. Contributions from readers are earnestly solicited and will be acknowledged when used.

Von Frisch on Orientation in Bees. In a recent paper[1] entitled: "Competition between the heavens and the earth in the orientation of bees," Professor KARL VON FRISCH and MARTIN

[1] VON FRISCH, K. UND M. LINDAUER, 1954. Himmel und Erde in Konkurrenz bei der Orientierung der Bienen. Die Naturwissenschaften 41: 245–253.

LINDAUER have added greatly to our knowledge of the means that bees use in finding their way between their feeding place and their hive. Earlier papers by von Frisch,[2] and by his student Lindauer [3] have been reviewed previously in the pages of ENTOMOLOGICAL NEWS.

In this paper we learn of the use that bees make of landmarks (features of the landscape) as well as of their use of the sky-compass (position of the sun, and the direction of vibration of the polarized light from the blue sky that is dependent on the sun's position) in directing their flights.

If one trains bees to a feeding station in a certain direction from the hive, and if these bees are then moved overnight to a new and distant locality, they will, in the morning, immediately set out to search for food in the same direction and at the same distance as on the previous afternoon.

In one experiment, for example, bees were trained to anise-flavored sugar solution, 600 feet west of the hive. The locality was a narrow mountain gorge and the bees had to fly through trees and across an arm of a lake to reach the food. The hive was then moved overnight to a locality of broad meadows where a food station had been set up 600 feet west of the hive, with similar stations to the north, south and east. In the morning, on their first flight, 27 of the 29 trained and numbered bees were observed again. Of these, 20 appeared at the west station, 5 at the south, and 1 at the east station. Each bee was captured when it made its first appearance at a station, so that there was no dance communication with others. Of 12 experiments of this sort, 2 were negative, and these were on days with an overcast sky. It seems, accordingly, that in addition to sighting the sun (we already know that for bees' eyes the sun is visible through the clouds), the presence of blue sky with its polarized light is necessary. This narrows down the question to this: Is the sight of the blue sky alone sufficient, without a direct view of the sun?

One afternoon, a hive was set up on a narrow strip of lake shore, along a narrow gauge track, at the base of a mountain.

[2] SCHMIEDER, R. G., 1947. Ent. News 58: 152–154.
[3] SCHMIEDER, R. G., 1952, 1953. Ent. News 63: 100–102; 64: 262–265.

Here the hive was in the shadow of the mountain, and on their flights back and forth to the food station, in a SE direction, the bees were never out of the shadow—they never had a direct view of the sun, only of the blue sky. After one afternoon's training, the hive was moved overnight to a region of broad, open meadows. The next morning, the hive was opened and the flights of the bees to the four food stations that had been set up (in the NE, SE, NW, and SW) were observed. In overwhelming numbers the bees flew immediately to the SE, the training direction. This shows that a view of the blue sky suffices for orientation; and it also shows that although trained only during the late afternoon of one day, they were able to locate this same direction the next morning, even in a totally different landscape. Thus the bees must be able to calculate the right direction in relation to the sun (or to the polarization pattern of the sky that changes with the sun's position) for other times of the day than that for which they have been trained, and in any landscape. "Knowing then that the sun's position and the direction of vibration of the polarized light of the sky are linked together in this manner, one may imagine that the dome of the heavens must constitute a compass of convincing intensity to the comprehensive gaze of the bee's facetted eyes."

The next question taken up was: Are striking landmarks or is the sky-compass of greater significance in orientation? In a field partly enclosed by woods, a hive was set up close to a woods-field boundary, that ran straight north-south. The food station was placed ca. 600 feet south of the hive, so that the flights from hive to food were close and parallel to the woods. Moved overnight to a similar field and placed close to a woods boundary running east-west, the bees were found to disregard the original flight direction (which now would have taken them out into the open field, at right angles to the woods) and flew from the hive along the edge of the woods (which meant flying west, instead of south as in the first field).

On another afternoon, bees were trained on the shore of a lake, so that their flight closely paralleled the shore. They were

then removed overnight to another lake with a shore line running at right angles to that of the previous afternoon. Both lakes were in flat, open country, surrounded by meadows. In still another experiment, the bees and the food station were placed 600 feet apart and 3 feet from the edge of a straight stretch of country road. The next morning, the bees were tested beside a similar road but running at right angles to the first. In all these experiments it was the striking landmark that determined the orientation; bees disregarded the compass direction and followed the woods line, lake shore, or highway. Only when the training has been carried out at some distance from such a landmark does the sky-compass become the means of orientation. Apparently it is the *continuity* of the line of the lake shore, woods, etc., that so impresses the bee.

Bees were not influenced by a large tree close to their line of flight, or even by a grove of trees. When moved to a new location with a similar large tree or grove, again standing alone in a flat landscape, the bees nevertheless flew in the correct compass direction.—R. G. SCHMIEDER.

NOTICE

Beginning with the January issue 1955, ENTOMOLOGICAL NEWS will no longer include the "Current Entomological Literature." This section began with the very first issue of the NEWS in January, 1890, and has constituted, over the years, one of the important services that the NEWS has been happy to render its subscribers.

In recent years, the volume of papers published in entomology throughout the world has become so great that the listing of the titles is a function now performed by special bibliographic publications. This makes the work that the NEWS has been doing largely a duplication, the labor and expense of which can no longer find sufficient justification. Although many subscribers have found in the "Literature" an inexpensive and convenient

way of keeping abreast of current publication, the amount of space taken up in the journal (over 40% of its text pages during 1954) is far too great for material that is of only temporary value (since all titles appear later in the Zoological Record). It is felt that ENTOMOLOGICAL NEWS can be made a more valuable publication by devoting all its available space to original articles and to news items. Contributors will then find that their shorter scientific papers will appear in print without so long a delay, and, if our readers will cooperate by sending in news of recent advances, of events as well as personals, all will be better informed as to what is going on in the entomological world.

To subscribers who have heretofore depended upon "Current Entomological Literature," we suggest the use of the following:

BIBLIOGRAPHY OF AGRICULTURE. Edited by the U. S. Department of Agriculture Library; for sale by the Superintendent of Documents, Washington, D. C. $8.00 per year. The part on "Entomology" lists practically everything indexed in ENTOMOLOGICAL NEWS plus references to economic entomology. Published monthly, it carries an annual index, both author and subject, in its December number which appears early in January. Available in all U. S. depository libraries and in most others of a specialized nature.

AGRICULTURAL INDEX. The H. W. Wilson Co. 950–72 University Ave., New York 52, N. Y. (Covers many entomological and biological journals and Experiment Station publications.) $12.00 per year.

REVIEW OF APPLIED ENTOMOLOGY. Series A, *Agricultural.* 40 s. per year. Series B, *Medical and Veterinary.* 20 s. per year, post-paid. Issued by the Commonwealth Institute of Entomology, 41 Queen's Gate, London S.W. 7, England. (These journals print abstracts.)

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costs $50. Each of the five sections is available separately at from $5 to $9 per section.

ZOOLOGICAL RECORD. The *Insecta* section may be purchased separately from the Commonwealth Institute of Entomology, 41 Queen's Gate, London S.W. 7, England. The price for this section is 30 s., and it has the added advantage of appearing some months before the complete edition of the Record (for example, the section dealing principally with the literature of 1951 was published in February, 1953, while the completed volume appeared in November, 1953). The *Arachnida* section is smaller and the price is 7 s. 6 d., obtainable from the Zoological Society of London, Regent's Park, London, N.W. 1.

Current Entomological Literature

Compiled by VENIA T. PHILLIPS, Librarian

Academy of Natural Sciences of Philadelphia

Under the above head it is intended to note papers received at the Academy of Natural Sciences of Philadelphia and the University of Pennsylvania pertaining to entomology, including all arthropods except Crustacea. Coverage will be world-wide as regards major contributions to systematics as well as for all papers on morphology, physiology, embryology, etc. In addition, for species from the Americas and the Pacific (Nearctic, Neotropical and Polynesian regions) all minor contributions to taxonomy, distribution, etc., will also be recorded.

This list gives references of the year 1954 unless otherwise noted. Continued papers, with few exceptions, are recorded only at their first installment.

For other records of general literature and for economic literature, see the Bibliography of Agriculture, Washington, and the Review of Applied Entomology, Series A, London. For records of papers on medical entomology see Review of Applied Entomology, Series B.

NOTE: The figures within brackets [ ] refer to the journal in which the paper appeared, as numbered in the List of periodicals and serials published in our January and June issues. The number of the volume, and in some cases, the part, heft, &c. is followed by a colon (:). References to papers containing new forms or names not so stated in titles are followed by (*); if containing keys are followed by (k); papers pertaining exclusively to Neotropical species, and not so indicated in the title, have the symbol (S).

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A Book on German Dragonflies

In 1937 Miss Cynthia Longfield published a book of 220 pages, illustrated with text-figures and 38 plates, on the Dragonflies of the British Isles. A review by the late Prof. Clarence H. Kennedy, in the *Annals of the Entomological Society of America* (31: 180, June, 1938), brought this work to the attention of American students of these insects. In 1949 a second, enlarged edition of Miss Longfield's book appeared with 256 pages; a special feature was the inclusion of 12 colored plates from original drawings, prepared by W. F. Evans for private circulation in 1845, and 4 colored plates by C. A. Hammond. Now comes a comparable publication for German dragonflies: Die Libellen unserer Heimat, by Hans Schiemenz, of the Zoological Museum of the Humboldt University of Berlin, Urania Verlag, Jena, 1953, 154 pages, 30 plates in colors and 31 text-figures. The contents are divided into three parts: A—General part, on dragonflies and their ancestors, structure and functions of the dragonfly's body and the life of dragonflies; B—Special part on the systematics, identification and habits of the German dragonflies; C—Practical part, on the observation, capture and preparation of dragonflies, the rearing of their larvae in aquaria and an identification table for both imagos and larvae. There are a glossary, an (incomplete) bibliography of European Odonata from 1839, and alphabetical subject and author indexes.

Part B occupies more than a third of the book. Here each species is treated under the headings: size and coloring, distribution, biotope, flight period, pairing and oviposition, eggs, larvae, overwintering, developmental period and special mention.

The colored illustrations of the species are aquarelles by Kurt Schuster with, usually, backgrounds of appropriate vegetation or, in one case, the buildings on both sides of a city street through which an Aeschna cyanea is hunting its prey. The colors of the bodies are carefully executed, the wings are merely sketches which suggest the iridescent flutings but give no details of the all-important venation. In this respect they are inferior to the colored plates of Miss Longfield's second edition. There are, indeed, very few (4) figures of the venation throughout the book. Much information on the life, development, habits and general ecology of dragonflies is to be found in this book, some of it drawn from the author's own observations.

German, as well as the scientific, names are given for each species in order to make these insects known to wider circles. "Many people, above all the young, understandably enough, are frightened by the scientific Greek-Latin designations." Dr. E.

Straub has cooperated with the author in the selection of these German names. A few examples are Binsenjungfern for the genus Lestes, Glänzende Binsenjungfer for Lestes dryas, Gemeine Binsenjungfer for Lestes sponsa. The Aeschnidae are die Edellibellen, the genus Aeschna is the Mosaikjungfern, Aeschna grandis die Braune Mosaikjungfer, Aeschna coerulea die Alpen-Mosaikjungfer. Both Enallagma and Agrion (in the Selysian sense) are Azurjungfer, while the species names are based on the shapes of the black markings of abdominal segment 2, thus Becher-Azurjungfer for Enallagma cyathigerum. Incidentally, Calopteryx and Agrion are retained in the Selysian sense. The common names for the same species, in most cases, have not the same meaning in Miss Longfield's and Herr Schiemenz's books.

Herr Schiemenz lists 80 species for Germany, 2 of which are central European but not yet certainly recorded for Germany. Miss Longfield's total for the British Isles is 44.

No indication of price accompanies the copy of Herr Schiemenz's book which we have seen.

PHILIP P. CALVERT

INSECT METAMORPHOSIS; THE DRAGONFLY LARVA, by R. E. Snodgrass, Smithsonian Miscellaneous Collections, Vol. 122, No. 9, April 1, 1954; Vol. 123, No. 2, Sept. 21, 1954.

Readers of the NEWS whose memory goes back to 1927 will recall that in that year the first of Mr. Snodgrass's essays on the structure and functions of insects and of other arthropods was noticed in our pages. From time to time others of his series were reviewed. Now the two most recent have appeared and we are glad to signalize them.

The subject matter of Insect Metamorphosis is treated under 12 chapters headed: 1. Metamorphosis and classification, 2. Hormones and metamorphosis; one chapter each on the orders, 3. Apterygota, 4. Plecoptera, 5. Ephemeroptera, 6. Odonata, 7. Hemiptera and 8. Thysanoptera; the very suggestive ninth chapter is on the Oligoneoptera or typical Endopterygota: Neuroptera to Hymenoptera, 10. Larval heteromorphosis, 11. The pupal transformation; and 12. Muscle attachments and the nature of the pupa.

"True metamorphic characters, as here understood, are adaptive structures, temporarily assumed usually by the young insect for its own purposes, that have no phylogenetic counterpart in the adult evolution, and which are discarded at the transformation to the imago" (page 6). The term nymph is "limited to

the young of ametabolous or paurometabolous insects that in all essential respects, except those of immaturity, resemble their parents and have no important characters that obscure their likeness to the adult" (page 7). Larva is defined as "an immature post-embryonic stage that has acquired for its own use adaptive characters that its adult ancestors did not possess, or which are not carried over into its own winged instar" (page 7).

In connection with larval heteromorphosis much attention is given to parasitic larvae both with and without a planidial stage, meaning by the term planidial a stage in which the larva actively moves about "to find its host or to attach itself to a carrier which will transport it to the nest wherein are the host eggs or larvae on which it is destined to feed" (page 62).

"The reason for holometabolism, that is, for metamorphosis that involves the intervention of a pupal stage between the larva and the imago, is not to be found in the external characters of the larva. The young mayfly or the young dragonfly differ externally from their parents more than do the larvae of some endopterygote insects, but yet they transform without a pupal stage" (page 53). "The more different a larva becomes from the adult of its species, the more specialized its musculature must be, and, therefore, it is in such insects as Lepidoptera, Hymenoptera and Diptera that the greatest degree of muscle reconstruction occurs between larva and imago" (page 106). "The essence of holometabolism is the muscle transformation" (page 107).

There are slightly more than 13 pages of references at the end of the paper. Every entomologist, whatever be his special field of study, will find much to interest him in this essay.

The second of these contributions, on the dragonfly larva, emphasizes many features touched on in its predecessor. Special attention is given to the head, feeding apparatus, alimentary canal, thorax and abdomen. Some unusual points of view are expressed in the following quotations from the summary, pages 35–36. "The respiratory chamber of the intestine is probably the colon rather than the rectum. The cercoids are here regarded as true cerci. The caudal gills of zygopterous larvae are lobes of the epiproct and paraprocts. Only the thorax of the larva resembles the corresponding part of the adult; the larval head and abdomen are constructed entirely for purposes of the aquatic larva, the thorax serves equally well for both larva and adult." The final suggestion is made that "The dragonfly larva should be an interesting subject for experimental studies on the role played by hormones in metamorphosis."

Mr. Snodgrass's great ability is that of being able to stand off at a distance and view the relations of insect life which the rest of us, working in the forest, cannot see for the trees.

PHILIP P. CALVERT

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